Oklahoma Department of Environmental Quality
Air Quality Division
5 Year Network Assessment

Oklahoma Department of Environmental Quality
707 N. Robinson
P.O. Box 1677
Oklahoma City, OK 73101-1677

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Acronyms

µSA	Micropolitan Statistical Area
ADAM	Advanced Data Management
ANP	Annual Network Plan
AQI	Air Quality Index
AV	Air Vision
BAM	Beta Attenuation Monitor
CBSA	Core-Based Statistical Area
CFR	Code of Federal Regulations
EGU	Electricity Generating Unit
EPA	Environmental Protection Agency
FEM	Federal Equivalent Method
FIP	Federal Implementation Plan
FRM	Federal Reference Method
MFC	Mass Flow Controller
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standards
NO_x	Nitrogen Oxide
O_3	Ozone
OCS	Oklahoma Climatological Survey
ODEQ	Oklahoma Department of Environmental Quality
PAMS	Photochemical Assessment Monitoring Station
PM	Particulate Matter
PM 2.5	Particulate Matter less than 2.5µm
PM 10	Particulate Matter less than 10 µm
PSD	Prevention of Significant Deterioration
PWEI	Population Weighted Emission Index
QAPP	Quality Assurance Project Plan
RA40	Regional Administrator Required Monitoring
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SOP	Standard Operating Procedure
SPM	Special Purpose Monitor
SQL	Structured Query Language
TAPI	Teledyne Advanced Pollution Instruments
TEOM/FDMS	Tapered Element Oscillating Microbalance/Filter Dynamics Measurement
TF	Thermo Fisher
TSP	Total Suspended Particulates

Introduction

The U.S. Environmental Protection Agency (EPA) requires each state or local monitoring agency, where applicable, to conduct network assessments once every five years [40 CFR Part 58.10(d)]. Oklahoma is a rural state with four state Metropolitan Statistical Areas (MSAs) (Oklahoma City, Tulsa, Lawton, and Enid) and one state-shared MSA with Arkansas (Fort Smith). Oklahoma is currently in attainment with all National Ambient Air Quality Standards (NAAQS). The Oklahoma Department of Environmental Quality (ODEQ) believes that a full statistical analysis is unnecessary. ODEQ will take a straightforward approach toward meeting the requirements posed by 40 CFR Part 58.10(d):

- Address if network meets requirements as defined in 40 CFR Part 58 Appendix D.
- Determine if new sites are necessary.
- Determine if existing sites can be removed.
- Evaluate/discuss new technologies and the possibility of their incorporation into the network.

<u>Contacts</u>

East Region Manager
Name: Curt Goeller
Phone: (405)702-4126
Email: Curt.Goeller@deq.ok.gov

West Region Manager
Name: Kent Stafford
Phone: (405)702-4139
Email: Kent.Stafford@deq.ok.gov

Area Served

Oklahoma Topography

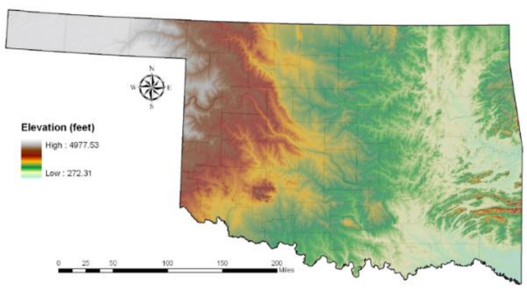

Figure 1: Oklahoma Elevations above Sea Level. (Source: Oklahoma Climatological Survey)

Characteristic of its location in the Great Plains, Oklahoma’s terrain is fairly flat on the western side of the state. Rolling hills begin around central Oklahoma and stretch into eastern Oklahoma. There are some aberrations from the mostly flat plains in the west (Wichita Mountains), in the south (Arbuckle Mountains), and in the east (Ouachita Mountains and the mountains of the Arkansas River Valley).[1]

Oklahoma generally sees a gain in elevation moving from east to west, ranging from 287 feet above sea level in southeastern Oklahoma to 4,973 feet above sea level in the far northwestern panhandle. Deviations such as the Ouachita Mountains in southeast Oklahoma see elevations ranging from 500 to 2,700 feet.[2] Oklahoma has several diverse features outside of mountain ranges, such as the Black Mesa complex in the panhandle. The Ozark Plateau in the northeastern section of Oklahoma contains rolling hills patterned with steep river valleys.

Oklahoma is comprised of two river basins – the Arkansas-White River Basin and the Red River Basin – that are part of the larger Mississippi River Basin.[3] Within the state, the Arkansas River Basin is comprised of tributaries Cimarron, Canadian, Verdigris, and Neosho, draining the upper two-thirds of the state.[4] Oklahoma's Red River Basin is comprised of the Washita and Kiamichi Rivers. It drains the lower third of the state and also serves as the southern border.[5]

Figure 2: River Basins within the Mississippi River Basin (Source: LSU College of Agriculture)

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[1] http://climate.ok.gov/index.php/site/page/climate_of_oklahoma
[2] https://www.fs.usda.gov/detailfull/ouachita/home/?cid=fsm9_039689
[3] http://www.lsuagcenter.com/profiles/lbenedict/articles/page1515431998585
[4] https://coyotegulch.blog/2018/04/02/arkansas-river-basin-water-forum-april-11-12-2018/
[5] https://geology.com/lakes-rivers-water/oklahoma.shtml

Oklahoma Climate

The climate of Oklahoma varies greatly from west to east. Prevailing winds from the south and southeast pull warm, moist air from the Gulf of Mexico over much of the central to southeastern portions of the state, creating a humid subtropical environment. These patterns bring the moisture needed for the state's spring and autumn storm seasons. A great deal of the moisture from the Gulf of Mexico does not reach the north to northwest sections of the state; with few other sources to provide moisture to Oklahoma, most of that area's climate is closer to semi-arid.[1]

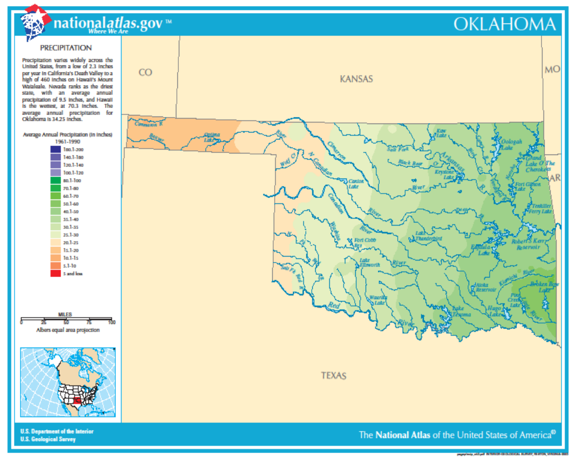


Figure 3: Oklahoma Precipitation Map

Temperatures tend to climb from mid to late spring into the summer, often reaching or exceeding 100ºF. Temperatures do not often drop again until mid-autumn, leading to much longer, harsher summers and often milder, shorter winters. Winter temperatures rarely drop below 0ºF.[2]

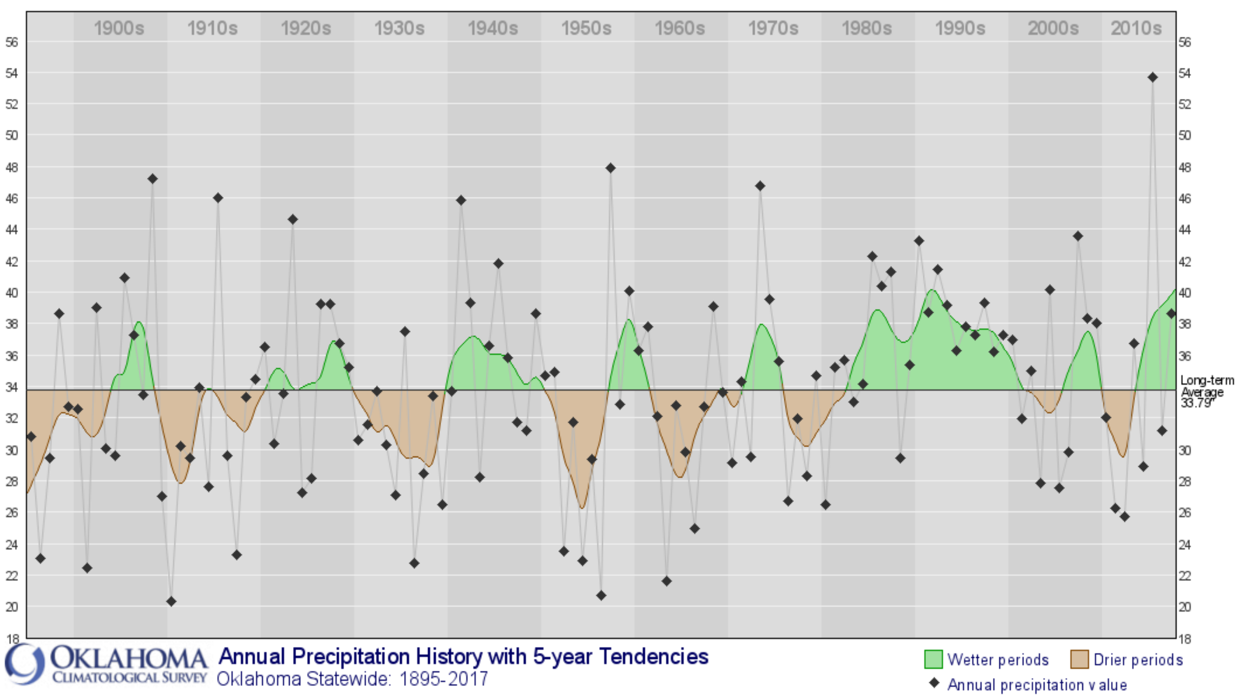


Figure 4: Graph shows Annual Precipitation with 5-year tendencies beginning in 1895.

[1] http://climate.ok.gov/index.php/site/page/climate_of_oklahoma
[2] http://cig.mesonet.org/climateatlas/doc60.html

Oklahoma's rain patterns show a sharp gradient between the east (56 inches on average, yearly over approximately 115 days) and west (17 inches on average, yearly over approximately 45 days). This pattern is reversed for winter weather, with most snow falling in the western portions of the state. Most precipitation falls in May and September. The panhandle remains an outlier, seeing its most significant amount of rain in July.[1]

Between Oklahoma's temperature and humidity, relative humidity throughout the state averages from 60% to 70% and often negatively impacts air quality monitoring. Most instruments are housed within air conditioned buildings to maintain temperature stability. With dewpoints reaching into the 80s in the summer months, condensation within instruments, sample lines, or manifolds is possible. Most PM 2.5 (Particulate Matter less than 2.5 µm) monitors have heated inlets to counteract this issue but may have difficulty removing all moisture on Oklahoma's most humid days.

Drought and flooding are recurring parts of the Oklahoma weather cycle. Periods of drought in Oklahoma can last anywhere from months to years, creating an elevated chance of wildfires and costing the state billions of dollars in farm damage. Flooding can occur at any time but is often associated with the spring and autumn rain increase. Flash flooding is still a major threat to many Oklahomans as urban and suburban areas continue to develop and expand, creating more opportunity for runoff.[2] Oklahoma Climatological Survey's (OCS) Climate Trends graphic (Figure 4) shows the evolution of Oklahoma's precipitation history since the modern record began in 1895.[3]

[1] http://climate.ok.gov/county_climate/Products/oklahoma_climate_overview.pdf
[2] http://climate.ok.gov/county_climate/Products/oklahoma_climate_overview.pdf
[3]http://climate.ok.gov/index.php/climate/climate_trends/precipitation_history_annual_statewide/CD00/prcp/Annual/oklahoma_climate

Oklahoma's Topography and Climate Effects on Air Pollution and Monitoring

Topography

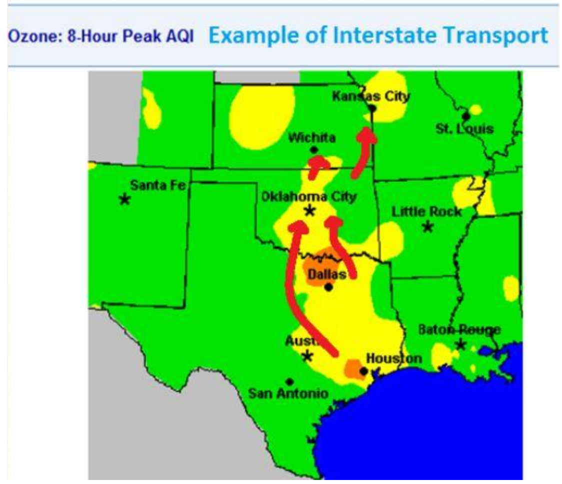


Figure 5: Example of Interstate Transport of Ozone illustrated by 8-hour peak AQI values.

There are relatively few deep river basins or valleys in Oklahoma that serve to trap air pollution for any extended period of time. Therefore, ozone (O_3) episodes tend to be of short duration. Due to the relatively flat terrain and prevailing south winds, the Oklahoma City, Tulsa, and Lawton areas can be influenced by O_3 transport from the Dallas/Ft. Worth area during transport events, lasting for only a day or a few days at a time. On a more localized scale, the Arkansas River valley (located west of Tulsa) winds through an area of small hills, which are capable of funneling O_3 and precursors toward the Keystone Lake area on days with an easterly wind. These transport events are rare and usually last 24 hours. Transport events differ from stagnation events in their wind speeds. Transport events occur when winds bring O_3 and its precursors from outside of Oklahoma, most notably when the predominant southerly wind pattern brings mobile emissions from Houston and/or Dallas/Ft. Worth into the state, as seen in Figure 5.[1] Stagnation events occur when O_3 levels are high at ground level due to low or no wind conditions for extended periods. The O_3 created in this scenario is due to locally emitted precursors. Stagnation events occur often, but extended events lasting over a week occur about once every ten years, usually during summer when high atmospheric pressure causes clear skies, heat, and calm conditions. During those stagnation events, the O_3 levels at monitoring sites in an MSA can reach unhealthy levels.

Regional-scale particulate pollution is highest in the lower elevations of eastern Oklahoma and gradually decreases to very low levels as one moves west towards higher elevations. The bulk of fine particulate values in eastern Oklahoma appear to be mostly related to sulfates and nitrates that originate from the Midwestern United States.

[1] http://envirofdok.org/wp-content/uploads/2017/03/Air-Carrie-Schroeder-Presentation.pdf

Climate

Air pollution concentrations are greatly influenced by the climate. Prevailing south-southeast winds occasionally bring O_3 and O_3 precursors from the south, causing unhealthy concentrations of O_3 in the southern half of the state. Inhalable particulates may also reach unhealthy concentrations when wildfires occur during the dry months of February, March, and April. Pollution events caused by air stagnation occur frequently throughout the summer, mostly during the months of July through August. These events, along with O_3 transport events, are among the easiest to predict and provide advance notice through the Ozone Watch program. Staff meteorologists consult daily weather models and EPA's AIRNOW forecast models in making these determinations. While Ozone Alert (Watch) predictions are not 100% accurate, the ability to make scientifically sound decisions in forecasting is improving as model accuracy improves. While heavy rainfall events tend to clear out pollution for short periods of time (up to a few days), there appears to be no correlation between statewide pollution concentrations (which increase from west to east), and statewide average annual rainfall amounts (which increase from west to east). Frontal passages, or fronts, commonly move through the state from northwest to southeast and bring cleaner air masses through the state for a few days at a time. Some pollutants, specifically O_3, can concentrate in higher values along the boundaries between warm moist air and cool dry air. It is difficult, if not impossible, to predict the location and duration of these types of O_3 events. Several instances of localized high O_3 concentrations have been observed as a result of this phenomenon, wherein one or two local monitoring sites register unusually high values and the remainder of O_3 sites do not.

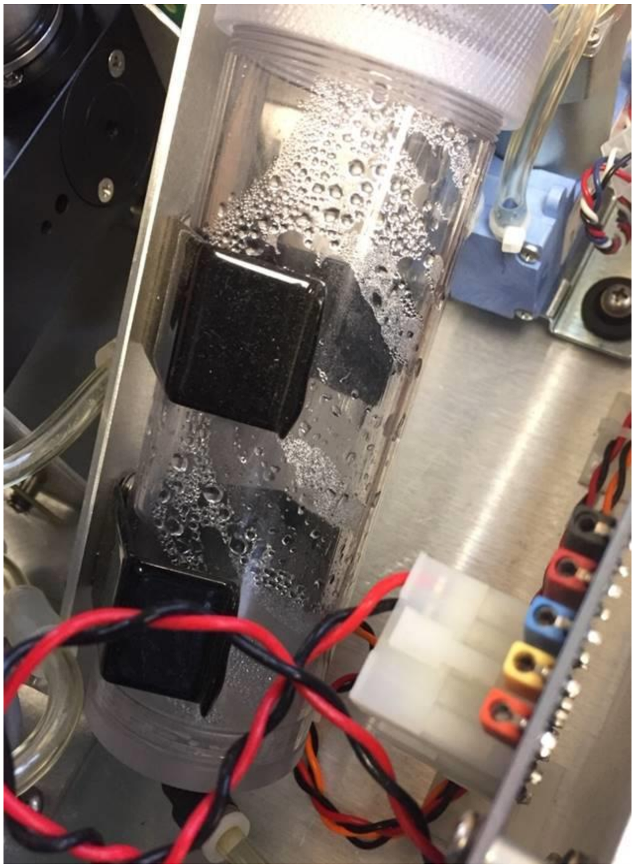


Figure 6: Condensation found in a Teledyne Advanced Pollution Instrument (TAPI) T640.

Population

Oklahoma is a rural state of approximately 3,943,079 people.[1]

CBSA	County	Population
Oklahoma City	Oklahoma	1,396,445
	Cleveland	
	Canadian	
	Grady	
	Logan	
	McClain	
	Lincoln	
Tulsa	Tulsa	993,797
	Rogers	
	Wagoner	
	Creek	
	Osage	
	Okmulgee	
	Pawnee	
Fort Smith	Le Flore	282,318
	Sequoyah	
	Sebastian	
	Crawford	
	Franklin	
Lawton	Comanche	126,198
	Cotton	
Stillwater	Payne	81,867
Shawnee	Pottawatomie	72,248
Muskogee	Muskogee	68,959
Enid	Garfield	60,913
Bartlesville	Washington	52,016
Tahlequah	Cherokee	48,675
Ardmore	Carter	48,177
Ponca City	Kay	44,522
McAlester	Pittsburg	44,145
Duncan	Stephens	43,411
Durant	Bryan	47,192
Ada	Pontotoc	38,354
Miami	Ottawa	31,325
Weatherford	Custer	29,036
Altus	Jackson	25,213
Elk City	Beckham	21,709
Guymon	Texas	20,856
Woodward	Woodward	20,497

County not in CBSA	Population
Delaware	42,733
Mayes	41,107
McCurtain	32,703
Caddo	28,977
Garvin	27,811
Seminole	24,578
Adair	22,082
McIntosh	19,815
Atoka	13,838
Marshal	16,806
Kingfisher	15,816
Choctaw	14,668
Craig	14,306
Murray	13,953
Hughes	13,335
Haskell	12,668
Okfuskee	12,098
Noble	11,289
Pushmataha	11,179
Washita	11,127
Johnston	10,949
Latimer	10,231
Nowata	10,218
Love	10,134
Blaine	9,485
Woods	8,897
Kiowa	8,729
Major	7,644
Tillman	7,348
Jefferson	6,123
Greer	5,821
Alfalfa	5,754
Coal	5,520
Beaver	5,319
Dewey	4,894
Grant	4,326
Harper	3,797
Roger Mills	3,656
Ellis	3,952
Harmon	2,664
Cimarron	2,153

[1] https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2018_PEPANNRES&prodType=table

Demographics

The air quality characterization, in terms of NAAQS comparable values, for areas with relatively high populations of susceptible individuals has not changed since the last five year network assessment was completed.

Area Emissions Sources

Oklahoma has an industrial base that dates back to the oil boom era of the early twentieth century. Although many refineries were established, only three remain and are all located in the eastern half of the state. There are several oil storage facilities in the state as well, with the largest located in Cushing in east-central Oklahoma. Five coal-fired power plants in the eastern half of Oklahoma have begun to move away partially, if not completely, from coal to natural gas. Since 2014, Oklahoma has seen over a 50% drop in coal usage from 29,905,952 megawatt hours to 14,906,747 by the electric power industry. This has been replaced by a jump in natural gas usage by over 50% and wind usage by over 129%.[1] Per ODEQ's State Implementation Plan (SIP) and Federal Implementation Plan (FIP), six power plants were required to reduce Nitrogen Oxide (NOx) emissions and three were required to reduce Sulfur Dioxide (SO_2) emissions over five years. All of the power plants have installed control systems to comply with the SIP and FIP; most have complied with their limits.

The number of major sources has continued to drop since 2014, from 348 to 324 (through 2018). An increase in major sources does not appear likely for the next five years as the shift to a service-based economy and renewable energies continues; however, Oklahoma sources tend to fluctuate based on the condition of the economy. Being primarily centered on oil and gas, Oklahoma emissions vary substantially year to year based on how much oil and gas exploration and production is occurring.

Oklahoma's fire season occurs in spring or autumn and contributes to PM and O_3 precursors. To conserve Oklahoma's local flora and prevent massive wildfire outbreaks, land management operations carry out prescribed burns, the largest being in the southeastern forests and the northeastern tallgrass prairies. Though these are conducted with basic smoke management practices, ODEQ maintains PM 2.5, Particulate Matter less than 10 µm (PM 10) and O_3 monitors near locations that might be affected by smoke from these burns. Emissions trends graphs will be included in pollutant-specific discussions later within this assessment.

[1] Administration, U.E. (2019, 10 22). Electricity. Retrieved from EIA: https://www.eia.gov/electricity/data/state/

Current Air Quality Conditions

Oklahoma is in attainment of all NAAQS.

Oklahoma Monitoring Network

Network Logistics

The Monitoring Section of AQD is comprised of two geographically divided sections: East and West. Please see Appendix A for staffing patterns. Sites and instruments are checked for quality and maintained on schedule as per the ODEQ Ambient Air Monitoring Quality Assurance Project Plan (QAPP). The data collection process for ODEQ is as follows:

Continuous Monitors

A. The Site Data Logger

   Each ambient air monitoring site with a continuous monitor has a data logger as its central storage location for data. All data loggers are standardized Agilaire LLC, model 8872 PC-based loggers. The 8872 logger uses Structured Query Language (SQL) Express as its database management system. The database and front-end software were developed by Agilaire LLC specifically to use for ambient air monitoring systems.

   The logger software, AV-Trend, manages communications for many types of continuous instruments. The two main types ODEQ uses is Modbus-capable and non-Modbus capable (analog).

   1. Modbus-Capable Instruments

      Modbus-capable instruments make up the majority of the Oklahoma's ambient air monitoring network. Examples of these instruments are Ozone, Sulfur Dioxide, Nitrogen Dioxide, Carbon Monoxide, Particulate Matter 10 and 2.5 (FEM) and Hydrogen Sulfide. Each of these instruments connects directly with the site data logger or through a standard switch that, in turn, connects to the data logger. The AV-Trend software polls each instrument on the network at regular intervals as defined by that instrument's communications driver, which can be customized to meet the network's needs on a parameter by parameter basis. It does so using Modbus protocol across an Ethernet cable. Once polled, that data is averaged by the data logger every one minute to get a one-minute average that is stored in the SQL database. Every hour, the software averages 60 1-minute averages to get an hourly average that is also stored in the SQL database. The formatting of this data is easily customizable according to each parameter's needs.

2. Non-Modbus Capable (Analog) Instruments

   Examples of analog instruments in the Oklahoma air monitoring network are mostly confined to meteorological data, i.e. wind speed/direction, ambient temperature, site temperature, and relative humidity. These instruments connect directly to the data logger and the electrical signal generated by the instrument is interpreted by an Advanced Data Management (ADAM) device that is user-configurable and user-customizable. Once the signal is translated by the ADAM from a signal to a value, that value is stored in the same SQL database described above. One-minute and hourly averages are calculated and averaged in the same way.

All continuous data now exists in the site logger database, ready to be transmitted to the central server.

B. The AirVision Central Server

   The AirVision (AV) central server, also developed by Agilaire LLC, is the permanent storage location for all of Oklahoma's ambient air monitoring data. It is located in the Air Monitoring Section of the ODEQ's main Oklahoma City office. This software, and its back-end SQL database, was designed to mirror that of each site's database so that they are compatible. The AV server can and is customized to poll each site's data logger at regular intervals. If the poll is successful, the data will be transferred from the site to the central server. Each data point is transmitted in floating-point format. The server itself is customizable in how to display the data to make it meaningful. Once polled, the data can then be subject to the QA process.

C. General Communications

   The AV server relies heavily on an IP-based communications system whose success is largely out of the control of the software itself. Once a poll is initiated to a specific site's IP address, the data request must travel through the ODEQ building's IT infrastructure, out to the State of Oklahoma's IT infrastructure, to our wireless carrier's cellular communications tower network and data center, back out to their transmission towers, which can then be received by the site's cellular modem. The modem will send the request to the data logger, which will respond to the request with the requested packet of data. That data stream then reverses and it is sent back to the AV server in the OKC office. This polling process, if successful, takes less than one second. Over 99% of all polling requests are successful.

Filter-Based Monitors

A. Lead – Lead data is recorded manually by each operator at the time of sample setup and collection. It is recorded on each sample's individual envelope. Envelopes are then sent en masse to the analytical laboratory. Once analyzed, the laboratory sends relevant data back to the ODEQ, where it is Quality Assured and subsequently submitted to the AQS database.

B. PM – PM filter data is collected with a combination of manual and digital means. The manual data is collected on the sample forms that pertain to chain of custody. The digital data, like flow, temperature, and pressure, are downloaded manually by each operator on each site visit. This data is then uploaded to the ODEQ network for permanent storage. At regular intervals, this data is transmitted via email to the analytical lab. Once analyzed, the laboratory sends relevant data back to the ODEQ, where it is Quality Assured and subsequently submitted to the AQS database.

Quality Control

ODEQ has multiple levels of quality assurance (QA) and quality control (QC) checks for all equipment. Instruments are evaluated by operators, primarily by using precision checks and Level I zero and span checks (ZSPs). PM monitors are typically evaluated using a point flow rate verification by the operator.

ODEQ's Primary Quality Assurance Organization (PQAO) is the Quality Assurance (QA) section for the Air Quality Division (AQD). The QA section is completely separate from the monitoring section as per the Quality Assurance Handbook for Air Pollution Measurement Systems Volume II, providing an additional independent review of all air quality data.[1] QA activities include implementing independent site and performance audits, data validation, and certification of all multi-gas transfer standards.

Gases for ZSPs and QA audits are purchased separately by Monitoring and QA from two different suppliers.

For further information on procedures, please refer to the ODEQ Ambient Air Monitoring QAPPS.

[1] https://www3.epa.gov/ttn/amtic/files/ambient/pm25/qa/Final%20Handbook%20Document%201_17.pdf

Evaluation:

ODEQ is of the opinion that its QA and QC procedures, as outlined in the QAPPs and Standard Operating Procedures (SOP), are robust enough to identify most data issues.

As pollution levels decrease, the Monitoring and QA sections intend to make spatial network adjustments and instrument changes for more accurate monitoring. QA plans to phase out the current Mass Flow Controller (MFC) range calibrators for extended range calibrators that will work with lower concentrations. Both Monitoring and QA will look into lower concentration gas bottles to make the adjustment more manageable.

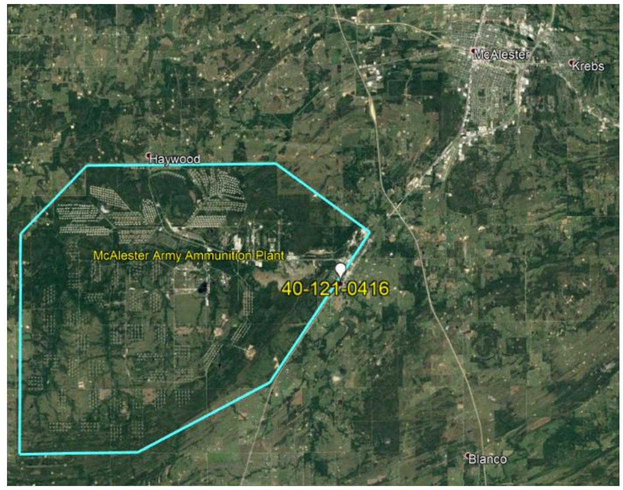
Currently, ODEQ is attempting to send gas bottles to the Ambient Air Gas Verification Program (AAGVP) to verify concentrations.

Criteria Pollutants

Lead

Summary:

Lead monitoring began in 1958 with one Total Suspended Particulate (TSP) monitor in Oklahoma City. After the TSP and lead NAAQS were promulgated in 1971, the network grew and samples were taken at many locations throughout Oklahoma. TSP and lead were measured by the same type of monitors and filter media. After the filter media was weighed for TSP, it was analyzed for lead. Lead and TSP monitoring were discontinued after 1999. TSP transitioned to PM 10 and the lead monitoring network requirements were relaxed nationally to require only one population-based site per EPA region and source-oriented sites for facilities emitting greater than five tons per year. Before this monitoring rule was implemented, several years of samples showed concentrations below detectable limits. Area source lead concentrations in ambient air trended downward drastically throughout the nation following the ban on leaded gasoline in the early 1970s.



Map 1: Current lead site as of publication date, monitoring the ammunition plant to the west.

ODEQ installed and operated two lead sites as a result of the 2010 lead NAAQS revision and an additional third site for the NCore lead requirement. Sites are operated using standard hi-volume sampler technology (TSP samplers) and filters are analyzed by a private lab using Federal Reference or Equivalent analysis methods. ODEQ chose not to use the EPA national contract for lead analysis.

Site 40-143-1127 (North Peoria-Tulsa) was an NCore required lead site. Site 40-121-0416 (Savanna) began operating to meet the source monitoring requirement for the McAlester Army Ammunition Plant. Site 40-037-0146 (Sapulpa) had two lead monitors put in place – a primary and collocated – to monitor the Ardagh Glass facility, which had previously exceeded the emission threshold of 0.5 tons/year for required monitoring. The NCore site's lead monitoring was discontinued with the elimination of the NCore lead monitoring rule at the end of 2016, following three years of measured concentrations well below the standard. Operation of the Savanna site was discontinued at the end of 2013 following three years of measured concentrations below or very near the minimum detectable limit, except for two sample values. It was then reinstated August of 2016 at the EPA's request due to an emissions increase at the ammunition plant.

Assessment:

Please see Appendix B for a list of our current lead monitors and a complete list of associated information.

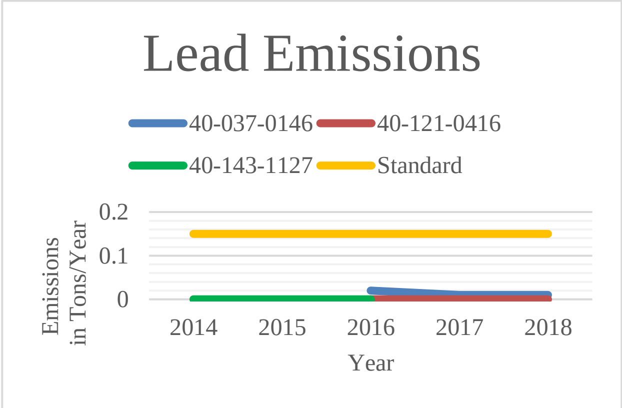


Figure 7: Lead values recorded by sites from 2014 to 2018.

Currently, the only location exceeding the 0.5 ton/year limit is the McAlester Army Ammunition Plant which is being monitored by the Savanna site.

There are two lead-emitting facilities near the 0.5 tons/year threshold:

- Mid-American Steel and Wire Co. in Madill, Oklahoma at 0.461 tons/year.
- International Paper in Valliant, Oklahoma at 0.455 tons/year.

ODEQ will continue to monitor the emissions inventory data for values surpassing the 0.5 tons/year threshold.

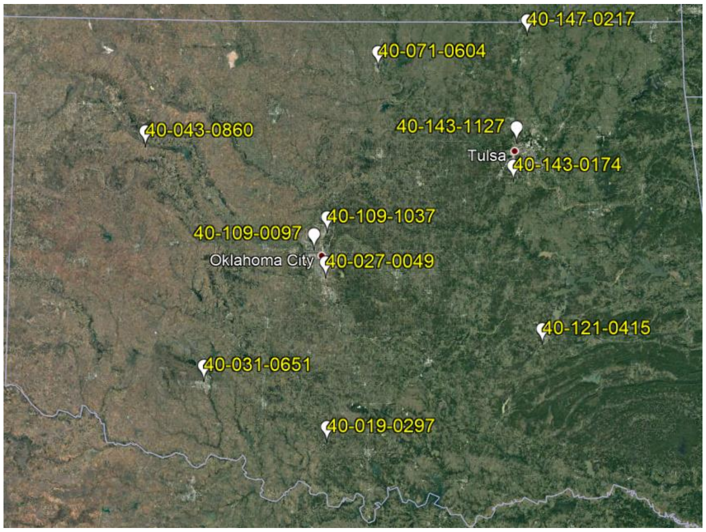
Since Ardagh Glass emissions have fallen below the 0.5 tons/year threshold, ODEQ has ceased monitoring for lead in Sapulpa.

There are relatively few lead sources in Oklahoma, and no other sources are expected to be added within the next five-year period; however, ODEQ will evaluate the emissions inventory data annually to ensure compliance with source-related network requirements.

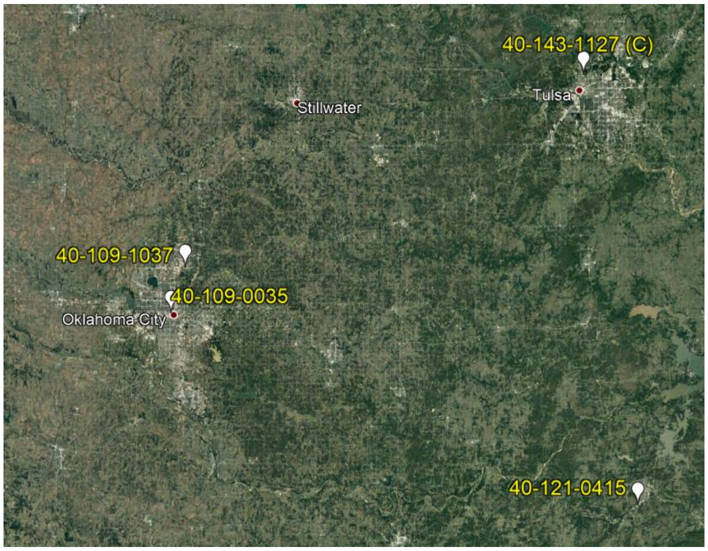
Particulate Matter < 2.5µm (PM 2.5)

Summary:

Monitoring for PM 2.5 began with promulgation of the PM 2.5 NAAQS in 1996. ODEQ was tasked with establishing 23 sites for the initial PM 2.5 network. Sampling began in 1997, but Federal Reference Method (FRM) quality control issues delayed collection of valid data until 1999. Oklahoma monitoring locations thus far have not exceeded NAAQS values. As a result, the size of the FRM network has been reduced incrementally over the years. Conversely, ODEQ has increased the number of Federal Equivalent Method (FEM) continuous samplers in order to enhance the Air Quality Health Advisory program and allow for the collection of higher resolution data for health studies. This transition from a predominantly manual sampling network to continuous samplers is represented in Figure 8 and reflects ODEQ's efforts to make higher resolution PM 2.5 data more readily available to the public in near real-time fashion.



Map 2: PM 2.5 continuous monitoring sites in the ODEQ network.



Map 3: PM 2.5 non-continuous monitoring in the ODEQ network. Site 1127 is collocated (Tulsa CBSA).

The few remaining FRM sites utilize Thermo Fisher (TF) 2025i technology and filters are analyzed by a private lab using Federal Reference or Equivalent analysis methods.

The continuous network has transitioned from the TF SHARP 5030/5030i monitors to Teledyne Advanced Pollution Instruments (TAPI) T640/T640x monitors over the last five years. This portion of the network supports the agency's daily Air Quality Index (AQI) reporting and Health Advisory program.

After extensive testing of the TAPI T640, ODEQ has found the samplers to be a significant improvement over the TF Tapered Element Oscillating Microbalance/Filter Dynamics Measurement System (TEOM/FDMS) and TF SHARP 5030 technology. The TAPI T640s have two advantages: they are capable of handling Oklahoma's humidity and are user-friendly.

Currently the ODEQ network maintains nine TAPI T640 monitors and two TAPI T640x monitors. ODEQ will continue to look for advances in PM 2.5 monitoring to improve network design.

ODEQ's network is currently at the minimum number of allowable FRMs and are not looking to further reduce this network. Any further changes to the network will likely be an addition or restructuring of current FEM instruments.

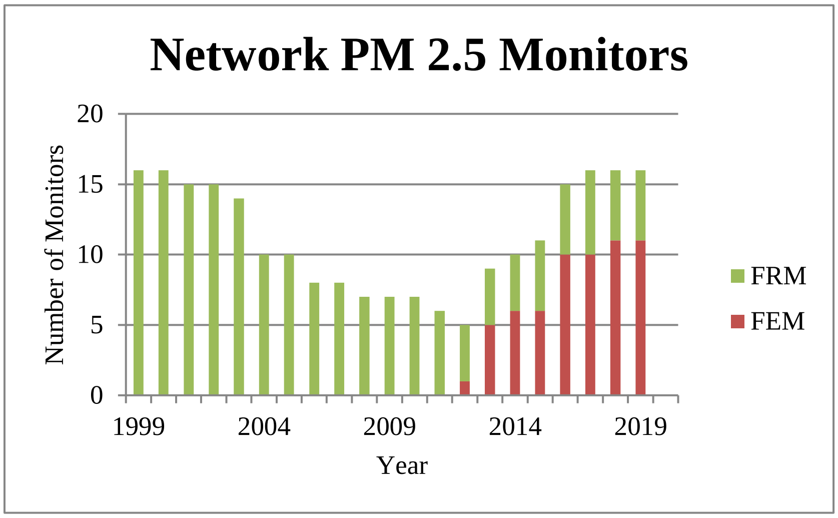


Figure 8: FRM v. FEM network over time, including collocated instruments.

ODEQ continues to recognize the following advantages of continuous monitors:

1. Less travel required for operation and maintenance.
2. Higher resolution (hourly) of data when samplers are operating properly.
3. No lab cost involved for data collection.
4. Real-time data access to notify the public when concentrations reach unhealthy levels for sensitive groups for Air Quality health advisories.

Despite difficulties faced by ODEQ in finding quality instruments, ODEQ has maintained an extensive PM 2.5 monitoring network for both NAAQS comparison and Oklahoma's own Air Quality (AQ) Health Advisory network. All NAAQS-comparable sites have maintained numbers well below the 24-hour NAAQS standard.

Assessment:

Please see Appendix B for a list of our current PM 2.5 monitors and a complete list of associated information.

Generally, Oklahoma drought and smoke trends have been on the rise over the last five years, making continuous monitoring a necessity to the Oklahoma Air Quality health advisory program. These monitors have been particularly useful during the springtime burn season. While some fires are local in size, the continuous network works well for larger fires such as the burning that occurs annually in the Flint Hills. An additional special purpose monitor (SPM) has been added in the northeastern section of Oklahoma (Nowata County) near the border of Kansas to gather data on the springtime Flint Hills burning. Oklahoma's daily PM 2.5 problems (high values) appear to stem almost exclusively from large seasonal agricultural burns. Those burns consist of a mix between prescribed burns and wildfires.

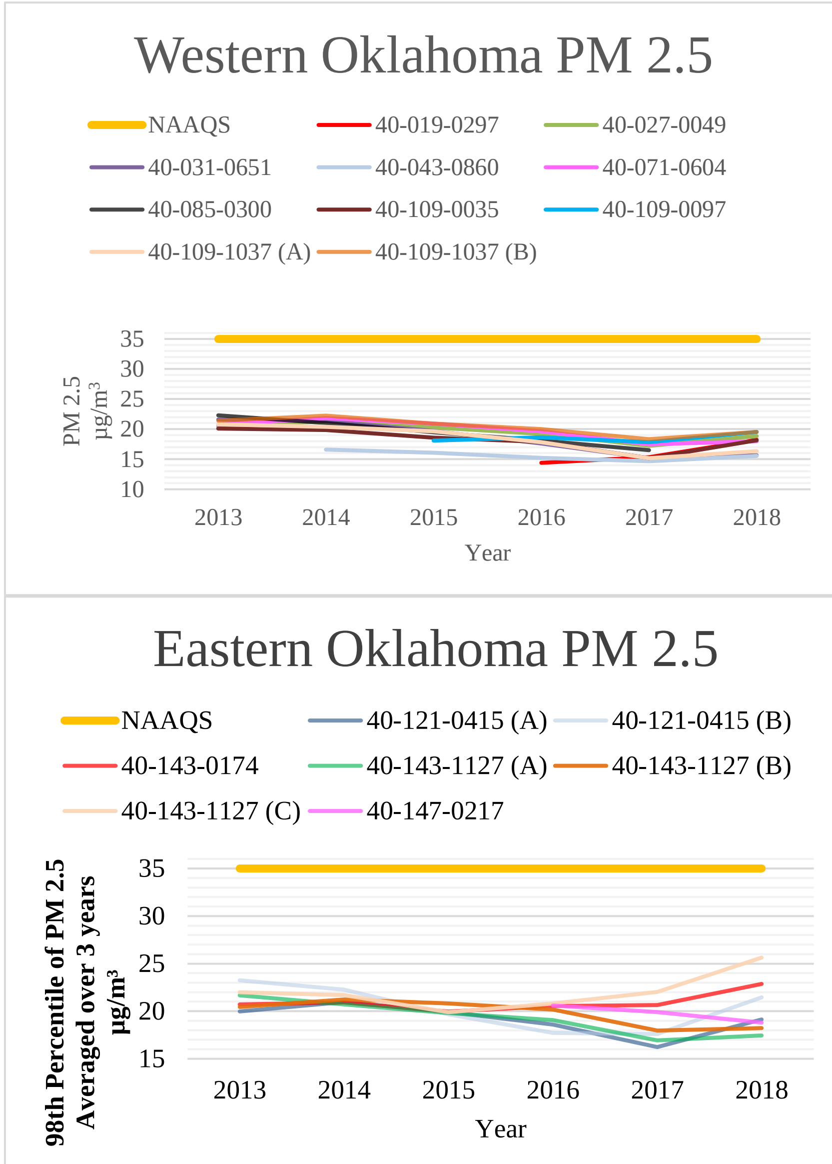


Figure 9: Western and Eastern Oklahoma 98th percentile of PM 2.5 averaged over 3 years comparisons to the NAAQS 24-hour standard. Sites without three continuous years of data were not graphed.

ODEQ's past experience with the TF TEOM/FDMS technology, the TF SHARP technology, and the TAPI T640 monitors has been marked by problems. The instruments upon receipt did not seem well tested; bugs were prevalent and instruments often failed or needed updates before use in the field. The TF TEOM/FDMS and TF SHARP 5030 instruments performed poorly in seasonally humid environments and had design limitations that frequently reduced data completeness. Though the TF SHARP 5030i handled the state's climate better than its predecessor, instrument engineering proved difficult to repair. The TAPI T640 seems to be an outlier for continuous PM

2.5 instrumentation, dealing with humidity in Oklahoma fairly efficiently in comparison to other instruments. Currently, the T640 has proven to be both efficient and effective for its intended purpose. Monitoring staff will continue to research consistent, reliable continuous methods to use in the PM 2.5 monitoring network and to provide quality data for NAAQS compliance, AQI, and the Health Advisory program.

ODEQ has begun to investigate other instruments, such as the Beta Attenuation Monitor (BAM) and small sensors such as the Purple Air monitors. These smaller, easily portable PM 2.5 monitors could test potential siting areas for appreciable pollutant levels before establishing compliance or Special Purpose Monitoring sites. Monitoring of intrastate and interstate fire emissions could occur as fires develop, providing better real-time data to the AQ health advisory program to the benefit of Oklahoma citizens.

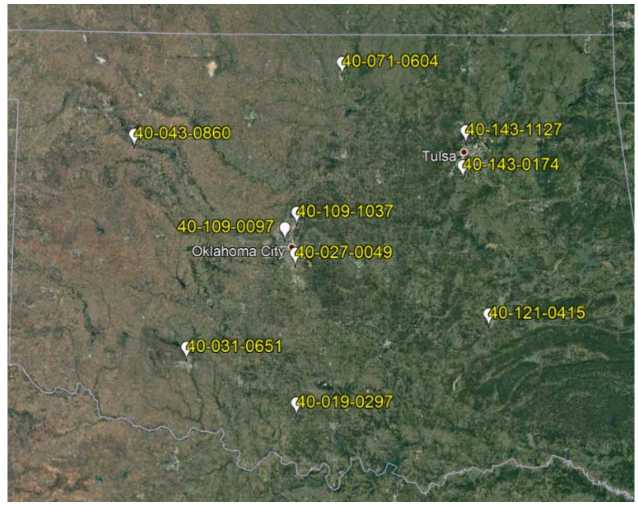
ODEQ's current PM 2.5 network meets minimum requirements. The network will likely not be expanded beyond its current size aside from potential special projects to monitor fire emissions and hydrocarbons from oil fields. ODEQ plans to maintain its non-required continuous network for its Health Advisory program and is working with vendors to improve data quality and completeness.

ODEQ will continue to observe current EPA directives/technological advances and update the network as appropriate.

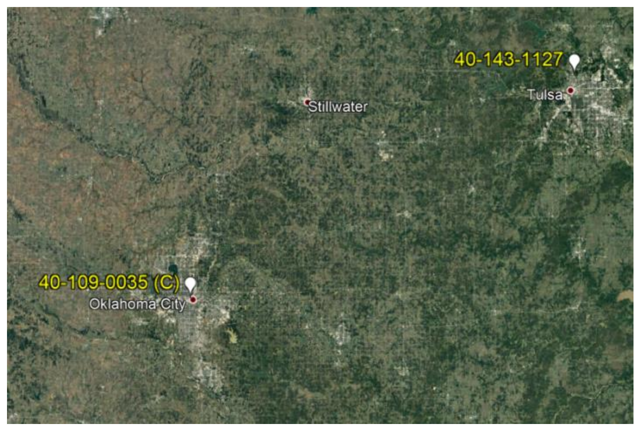
Particulate Matter < 10µm (PM 10)

Summary:

The first Oklahoma TSP site opened in Tulsa in 1972. In 1987, the TSP NAAQS was replaced by the PM 10 NAAQS. Originally, PM 10 samplers in Oklahoma City and Tulsa were operated by the City/County Health Departments. Responsibility for these monitors was transferred to ODEQ in the mid-1990s. Over the years, Oklahoma has operated more than 20 different sites collecting data. ODEQ has not detected any PM 10 values that necessitate having more than the minimum number of required samplers in any MSA, with the exception of one PM 10 site. This source-oriented site, AQS Site # 40-101-0167 (Muskogee), was removed in 2019 after major flooding.



Map 4: PM 10 continuous sites in the ODEQ network.



Map 5: PM 10 non-continuous sites in the ODEQ network. Site 40-109-0035 in the OKC CBSA is collocated.

The long-running Muskogee sampler historically captured higher than expected background values due to its proximity to several area sources. It was recently removed from service with the approval of EPA Region 6 since the area had become industrial instead of residential by nature. Collection was also halted at Weatherford in 2019 due to low PM 10 values; monitoring necessity was marginal at best for the area.

Currently, the Oklahoma PM 10 network consists of two TAPI T640x continuous samplers. These were installed at AQS Site # 40-143-1127 (North Peoria – Tulsa) and AQS Site # 40-109-1037 (Oklahoma Christian University – Oklahoma City), replacing the previous TF TEOM instrument at the latter. ODEQ also operates nine TAPI T640 base model instruments, which report both PM 2.5 and PM 10 (Map 4). The PM 10 on the base model, though not NAAQS-comparable, benefits the state's AQI and health advisory network. ODEQ also operates three required filter-based PM 10 2025i instruments: one at the NCore site, and a primary and additional collocated 2025i at AQS Site # 40-109-0035 Oklahoma City site (Map 5). These instruments are used to monitor long-term trends and population exposure.

Assessment:

Please see Appendix B for a list of our current PM 10 monitors and a complete list of associated information.

The ODEQ is continuing to reduce the PM 10 network in Oklahoma to maintain population monitoring, as lower PM sizes are increasingly becoming a primary concern.

At this time, ODEQ's network is robust enough to determine PM 10 pollutant trends and geographical distribution. When Tulsa reaches a population of 1 million, another PM 10 instrument will be added to the MSA as required by 40 CFR Appendix D to Part 58 §4.6. No further changes are expected to the network outside of this unless mandated by EPA.

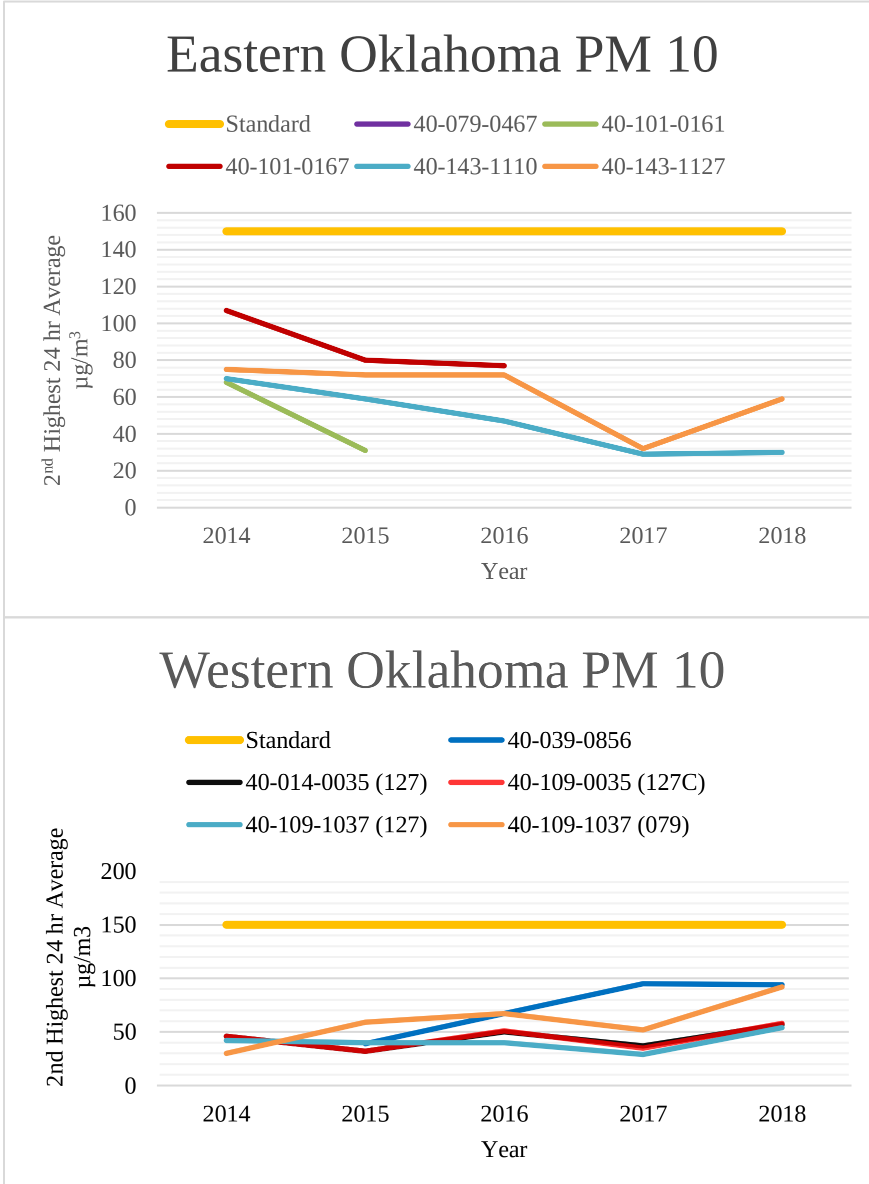
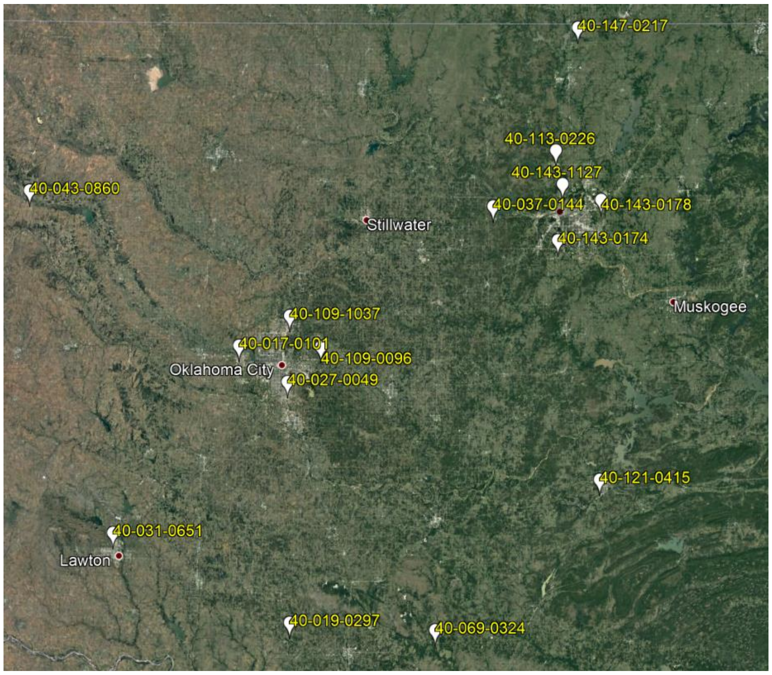


Figure 10: Western/Eastern Oklahoma monitoring data for PM 10. The set of numbers in the parentheses denotes method number and the C represents collocation.

Ozone (O_3)

Summary:

The Oklahoma ozone monitoring network began operating in the early 1970s. Fifteen sites are currently in operation. Most are situated in the four cardinal directions from the two major MSA centers in Oklahoma: Oklahoma City and Tulsa. Tulsa has an extra ozone site located at AQS Site # 40-143-1127 (North Peoria – Tulsa), the NCore site north of the city center. There is also one monitor at AQS site # 40-031-0651 (Lawton) to cover the Lawton MSA.



Map 6: Ozone monitoring sites in the ODEQ network. Note the two Red River SPMs along the southern border.

Outside of the MSAs, ODEQ installed regional-scale monitors at AQS Site # 40-121-0415 (McAlester) and AQS Site # 40-043-0860 (Seiling) (Map 6). McAlester primarily detects regional transport while Seiling detects background ozone levels. These sites were specifically chosen to fill large geographical gaps in the ODEQ network and to determine rural background concentrations. Their geographic distribution also assists the health advisory program.

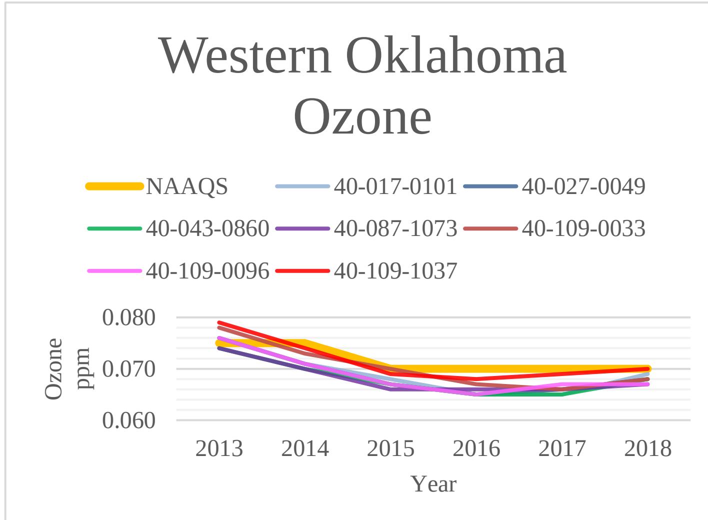
The remaining sites are special purpose monitors (SPMs). The Village Green bench in Oklahoma City is set up for the ongoing ODEQ small sensors study, which includes ozone sensors. Though the data is not submitted to AQS, it is an invaluable asset to the ODEQ's AQ Health Advisory Network. Three more special purpose monitors are situated near state borders to monitor interstate transport. One monitor is located in the northeast of Oklahoma to detect burning in the Kansas Flint Hills. Two monitors at the southern Red River border serve to identify ozone transport from northern Texas. These three sites each have two variable locations, moving every two years for more efficient coverage and use of monitoring personnel.

Assessment:

Please see Appendix B for a list of our current O_3 monitors and a complete list of associated information.

ODEQ currently has several ongoing changes to the O_3 network. AQS Site # 40-087-1073 (Goldsby) was shut down in 2019 because recent nearby construction affected siting criteria. ODEQ intends to move the site to AQS Site # 40-087-1074 (Kessler). ODEQ is working with the University of Oklahoma to create a contract for the placement of instrumentation at the Kessler Atmospheric and Ecological Field station located in Purcell. Once an agreement is reached, the site can begin data collection.

ODEQ is also in the process of adding a site within Great Plains State Park in Kiowa County to extend the western limit of the current network. This site will serve to monitor and identify background and/or ozone transport. Site setup is pending approval.



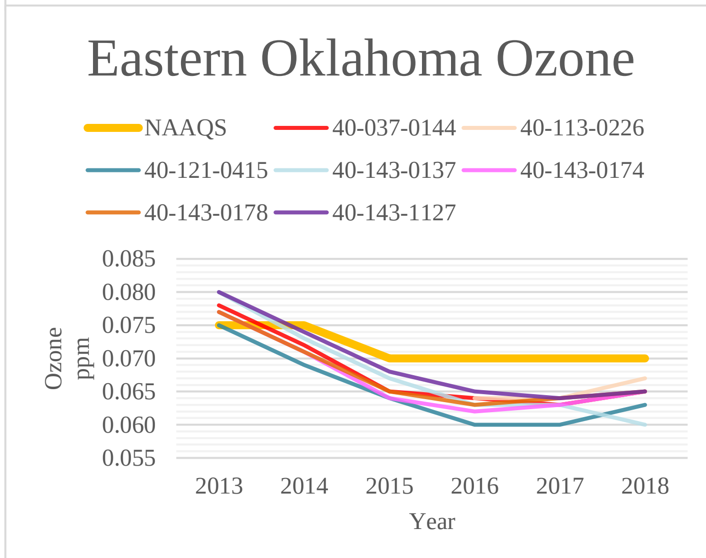


Figure 11: Western and Eastern Oklahoma ozone annual 4th high 8-hour rolling average over 3 years compared to the NAAQS.

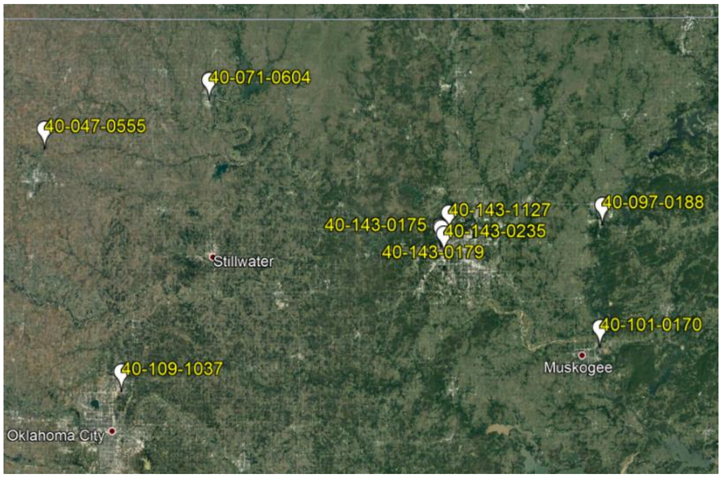
ODEQ is also coordinating with the city of Glenpool to move AQS Site # 40-143-0174 (Glenpool) south of its current location by approximately one mile. ODEQ will continue to watch the site closely to ensure that it maintains siting criteria.

ODEQ has identified that these additions and adjustments in the current network ensure the ability to determine ozone trends and geographical distribution. ODEQ is of the opinion that the current configuration has been beneficial and necessary for supplementing EPA's ozone mapping program and gives ODEQ the ability to alert the public of harmful concentrations in near real-time on high ozone days via the AQ Health Advisories.

No further changes are expected to the network outside of this unless changes are mandated by EPA.

Sulfur Dioxide (SO_2)

Summary:



Map 7: All SO2 monitoring sites in the ODEQ network.

The SO_2 monitoring network was originally developed using a source-specific approach and has been expanded to include population exposure. One monitor is population-based, and four monitors are a combination of both. Population-based AQS Site # 40-109-1037 (Oklahoma Christian University – OKC) serves to determine background levels for the Prevention of Significant Deterioration (PSD) program. AQS Site # 40-071-0604 (Ponca City) is in an area of Major SO_2 sources and will be operated as long as resources are available. In Tulsa, AQS Site # 40-143-0175 (NewBlock Park – Tulsa), AQS Site # 40-143-0179 (Riverside – Tulsa), and AQS Site # 40-143-0235 (Water Department – Tulsa) are both source- and population-based. The Riverside site is in an area that has historically fielded numerous citizen complaints. The fourth Tulsa SO_2 monitor is a trace-level monitor at the NCore Site, AQS Site # 40-143-1127 (North Tulsa-Peoria). AQS Site # 40-101-0167 (Muskogee) was source-specific, monitoring emissions from a large coal-fired power plant but was recently shut down after AQS Site # 40-101-0170 was established to comply with SO2 Data Requirements Rule (DRR).

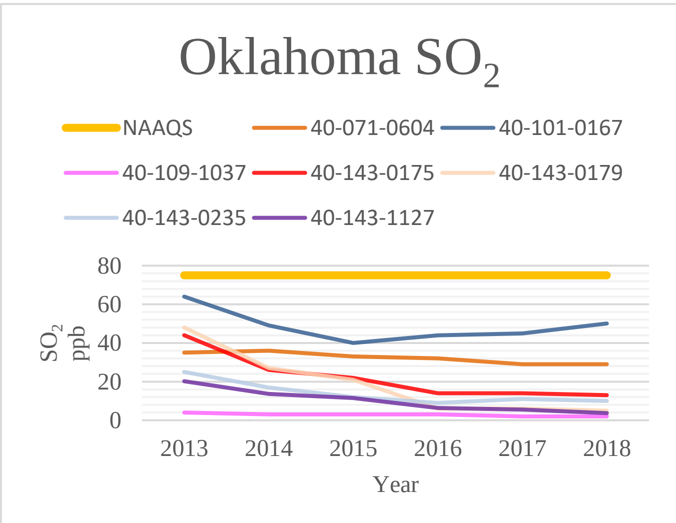


Figure 12: 99th percentile of 1-hour daily maximum SO_2 concentrations at all sites, averaged over three years.

Figure 13 shows oxides of sulfur (SO_x) in tons per year and the location of current SO_2 monitors. The emissions in this graph include all point, non-point, non-road, on-road, and event sources.

SO_2 monitoring is required where PWEI (Population Weighted Emission Index) values dictate. See Appendix B for all PWEI numbers. The only Core-Based Statistical Area (CBSA) requiring a source-oriented SO_2 sampler is Tulsa, with a PWEI value of 5,451 tons/million people. There is no requirement for SO_2 monitoring in the

Oklahoma City CBSA, which has a PWEI of 570 tons/million people.

In 2016, ODEQ set up three sites as required by the DRR: AQS Site # 40-101-0170 (Ft. Gibson), AQS Site # 40-101-0188 (Pryor), and AQS Site # 40-047-0555 (Kremlin).

Assessment:

Please see Appendix B for a list of our current SO_2 monitors and a complete list of associated information.

ODEQ plans to shut down the following SO_2 sites in the near future:

- AQS Site # 40-143-0179: This monitor is redundant to AQS Site # 40-143-0175 and the siting criteria is currently threatened by encroaching trees.
- AQS Site # 40-101-0170: This Data Requirements Rule (DRR) site should be removed within the next year due to design values being less than 50% of the NAAQS.
- AQS Site # 40-101-0188: This Data Requirements Rule (DRR) site should be removed within the next year due to design values being less than 50% of the NAAQS.

Even with the planned removal of AQS Site # 40-143-0179, ODEQ still exceeds the SO_2 CBSA requirement for the Tulsa CBSA.

ODEQ exceeds the minimum SO_2 network requirements. The agency reviews PWEI values annually for the Tulsa and Oklahoma City CBSAs but does not envision a network expansion as a result of increased emissions.

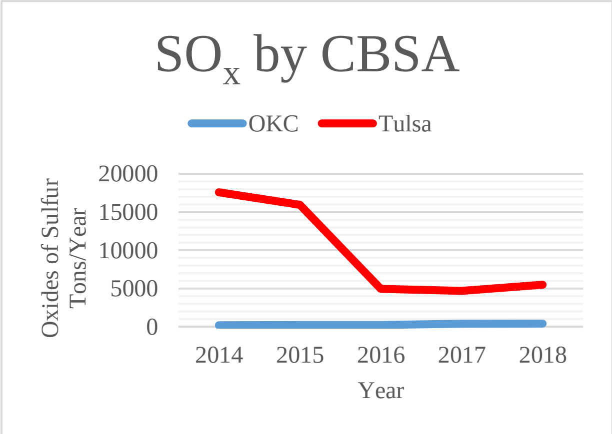
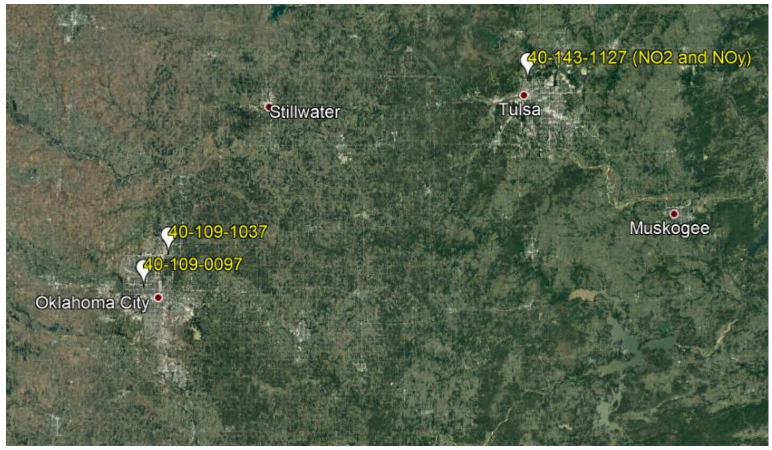


Figure 13: Emissions Inventory report of tons/year of SOx.

Nitrogen Dioxide (NO_2) and Reactive Nitrogen (NO_y)

Summary:



Map 8: NO_2 monitoring sites in the ODEQ network. NCore site 40-143-1127 also monitors NOy.

The NO_2 monitoring network was established to collect data for NAAQS comparison under 40 CFR Part 58 monitoring regulations and to supplement the O_3 network. Data are also used determine background concentrations in the PSD program. At its peak in the mid-1970s, the NO_2 network consisted of over 20 sites. Over the years, that network has been reduced dramatically due to low annual mean concentrations compared to the 53 ppb annual mean standard. As of January 2020, the network has been reduced to three sites. These three sites are located in our largest CBSAs, Oklahoma City and Tulsa, which also contain the highest annual NO_x emissions.

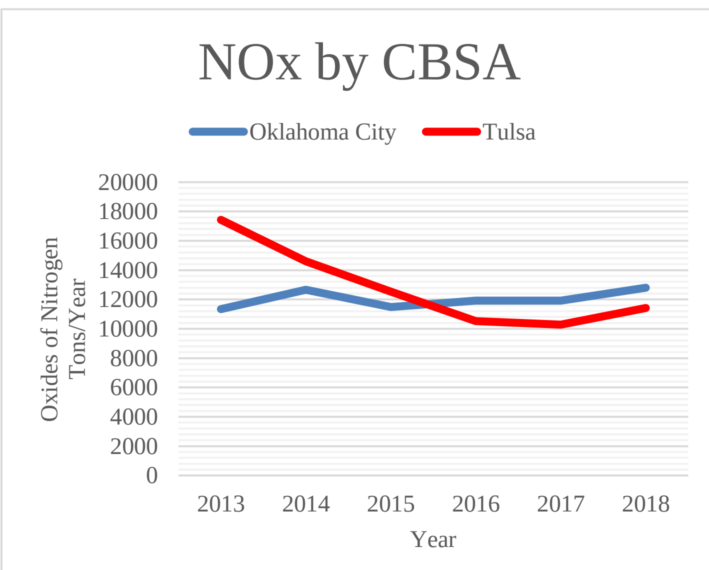


Figure 14: NO_x emissions by CBSA (OKC and Tulsa). Data obtained from ODEQ Emissions Inventory.

The three sites currently in operation include 40-143-1127 (NCore site located in the Tulsa CBSA), 40-109-0097 (Near-Road site), and 40-109-1037 (Area-Wide NO_2 and RA40 Regional Administrator Required Monitoring NO_2 for the OKC CBSA).

The NO_x at 40-143-1127 runs alongside the NO_y for comparison purposes.

Assessment:

Please see Appendix B for a list of our current NO_x monitors and a complete list of associated information.

Once the Tulsa CBSA population reaches 1 million, ODEQ expects an expansion as per CFR requirements. Upon reaching this threshold, a Near-Road site requiring a NO_x and a Photochemical Assessment Monitoring Station (PAMS) site requiring a direct NO_2 will have to be installed in the CBSA.

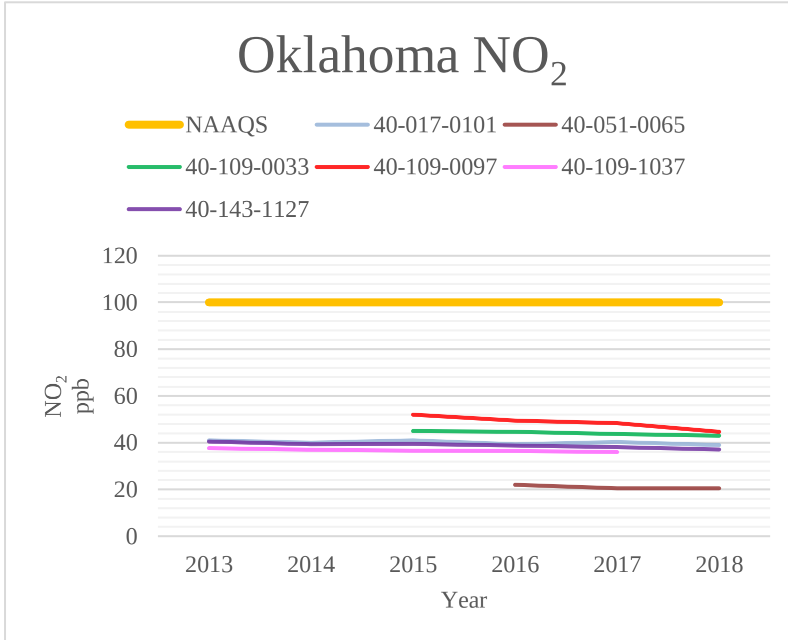
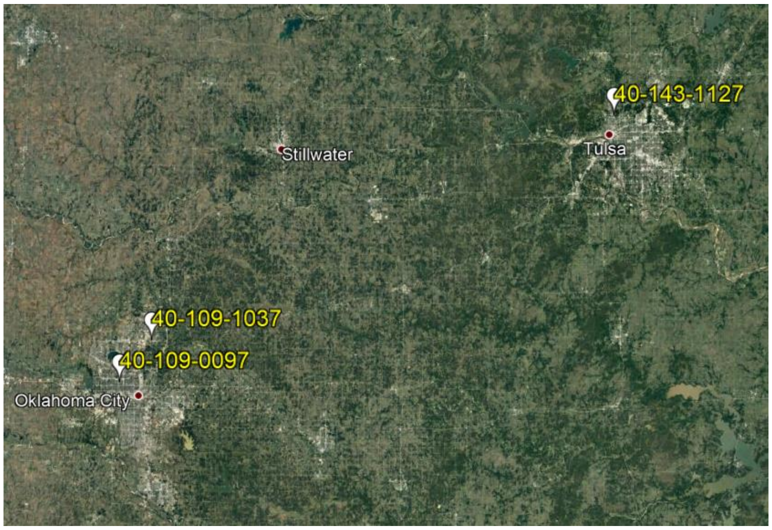


Figure 15: 98th percentile of 1-hour daily maximum NO_2 concentrations, averaged over 3 years.

As all three existing NO_x sites are required and essential, ODEQ is not making any long-term plans to reduce this network. Furthermore, recently observed concentrations in Population Exposure monitoring sites do not indicate a need for expansion; no further changes are expected to the network outside of this unless changes are mandated by EPA.

Carbon Monoxide (CO)

Summary:



Map 9: CO monitoring sites in the ODEQ network.

The carbon monoxide monitoring network was historically designed as a population-exposure effort. Attainment of the carbon monoxide NAAQS was achieved in the late 1980s after automobile emission controls improved and the older, higher polluting models of fleet vehicles were removed from service. At the time, the larger carbon monoxide network included some monitors which were situated using microscale site location criteria, i.e. close to neighborhoods and busy automobile traffic areas. Microscale sites for CO are no longer required for state or local networks; however, there is a requirement for collocation of a CO monitor at Near-Road NO_2 sites in cities with populations over 1 million. ODEQ meets this minimum requirement at our Near-Road site in AQS Site # 40-109-0097 (Near- Road Oklahoma City) and AQS Site # 40-143-1127 (North Peoria Tulsa).

With regards to major sources, the two largest metropolitan statistical areas (Oklahoma City and Tulsa) are experiencing downward trends for CO from Title V sources.

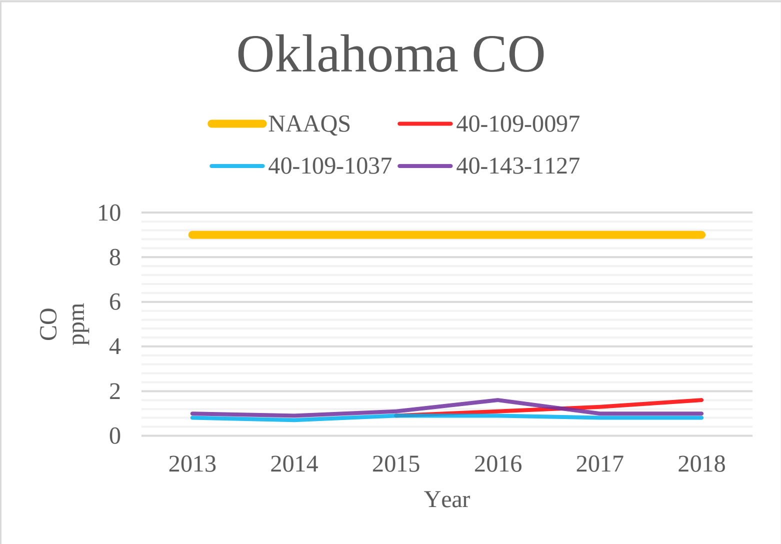


Figure 16: CO 8-hour averages, 2013-2018.

Aside from the Near-Road and NCore requirement, one site is currently operational at AQS Site # 40-109-1037 (Oklahoma Christian University). This site is NAAQS-comparable. These two sites remain useful for ongoing trends analysis in our the Oklahoma City MSA. After microscale siting requirements were eliminated in 2006, reductions in the CO network resulted in the current configuration of these three sites.

Assessment:

Please see Appendix B for a list of our current CO monitors and a complete list of associated information.

Site redundancy is a non-issue for this network due to the wide spatial distribution and coverage of the sites. ODEQ is not aware of new CO monitoring technologies that should be considered for deployment in the next few years.

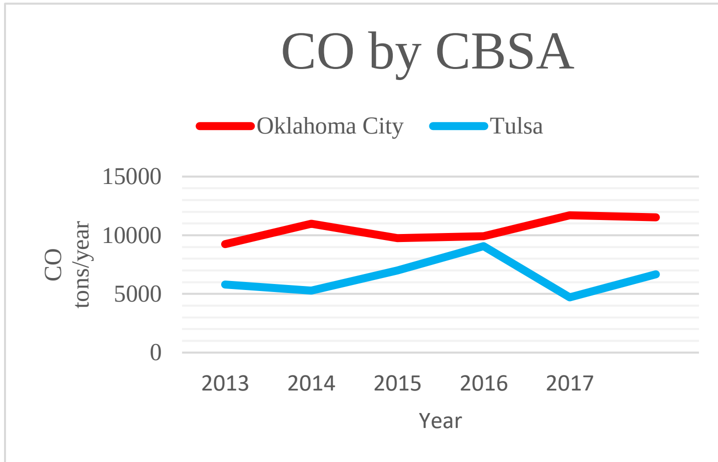
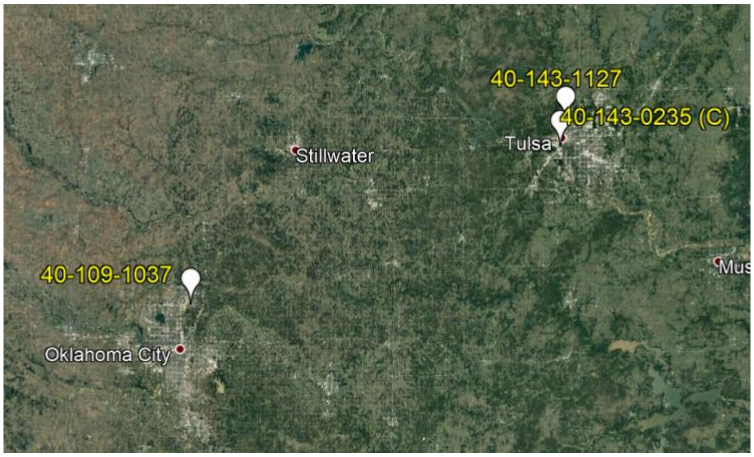


Figure 17: Emissions inventory of CO in 2 largest CBSAs.

ODEQ does expect an expansion per CFR requirements once the Tulsa CBSA population reaches 1 million. A Near-Road site requiring a collocated CO to the NO_x will have to be installed in the Tulsa CBSA once the 1 million person threshold is crossed.

No further changes are expected to the network unless mandated by the EPA.

Toxics



Map 10: ODEQ's toxics monitoring sites. (C) indicates a collocated site.

Until recently, ODEQ ran an extensive toxics network of seven sites across the state to address community concerns. Several of these sites were shut down due to budgetary constraints and low measured ambient concentrations in those areas over a monitoring period of two years. ODEQ currently runns three toxics sites at 40-109-1037 (Oklahoma Christian University – OKC), 40-143-1127 (North Peoria – Tulsa), and 40-143-0235 (Water Plant - Tulsa). All sites utilize canister sampling with carbonyls and TSP. ODEQ is currently in communication with EPA Region 6 to begin a National Air Toxics Trends Stations (NATTS), to be located at AQS Site # 40-143-1127 (North Peoria – Tulsa).

Special Projects

Small Sensors Study

ODEQ is one of several air monitoring agencies around the country that participates in EPA's *Village Green* program. This program consists of a park bench in Oklahoma City's Myriad Gardens specially outfitted with small air sensors that provide real-time pollution data for public health advisory programs.

Our agency is in the process of upgrading the bench to expand the project into a demonstration and testing platform for the many new miniature sensors that are coming onto the market. The following is a summary of sensors used at the bench.

Sensor	**Parameter(s) Measured**	**Status**
2B Tech OEM-106	Ozone	Active
Thermo pDR-1500	$PM_{2.5}$	Retired
Purple Air PA-II	PM_{10}, $PM_{2.5}$	Active
Vaisala HMP60	Temperature, Relative Humidity	Active
RM Young 05305V	Wind Speed and Direction	Active

Air pollution data collected by the Village Green project is non-regulatory and is intended to provide a general idea of pollution levels to the public. That being said, analysis of the collected data often shows strong correlation to nearby regulatory monitors as seen in Figures 18 and 19.

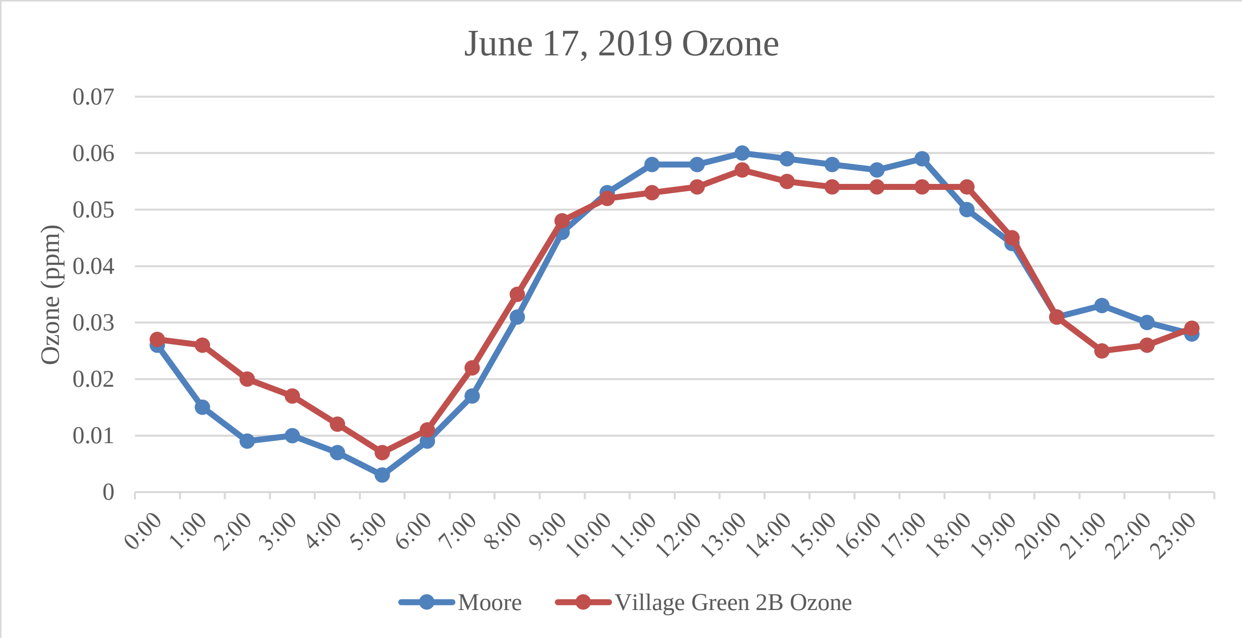


Figure 18: Comparison of ozone levels between Village Green and Moore on a given day.

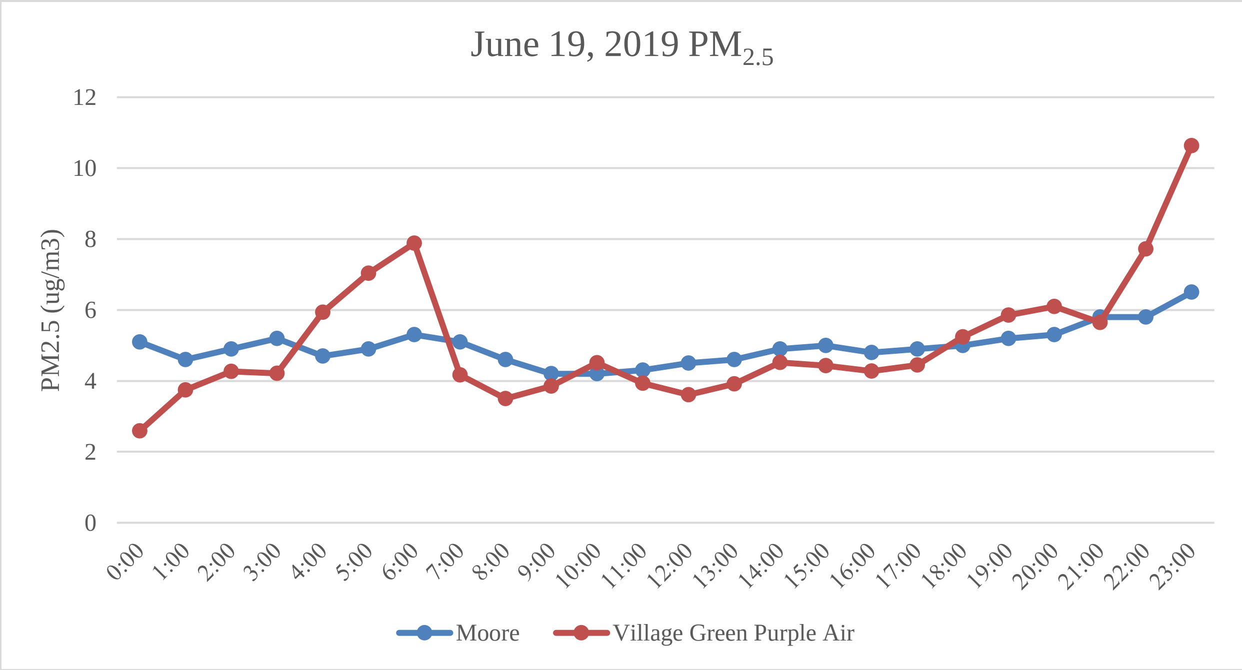


Figure 19: Comparison of PM 2.5 levels between Village Green and Moore on the same given day.

Long-Term Performance Project

Beginning Summer 2019, ODEQ began partnering with the EPA on the Long-Term Performance Project. Several types of small air sensors were collocated next to regulatory-grade monitors at the monitoring site located at Oklahoma Christian University (40-109-1037) to analyze the performance and accuracy of these sensors in a real-world setting.

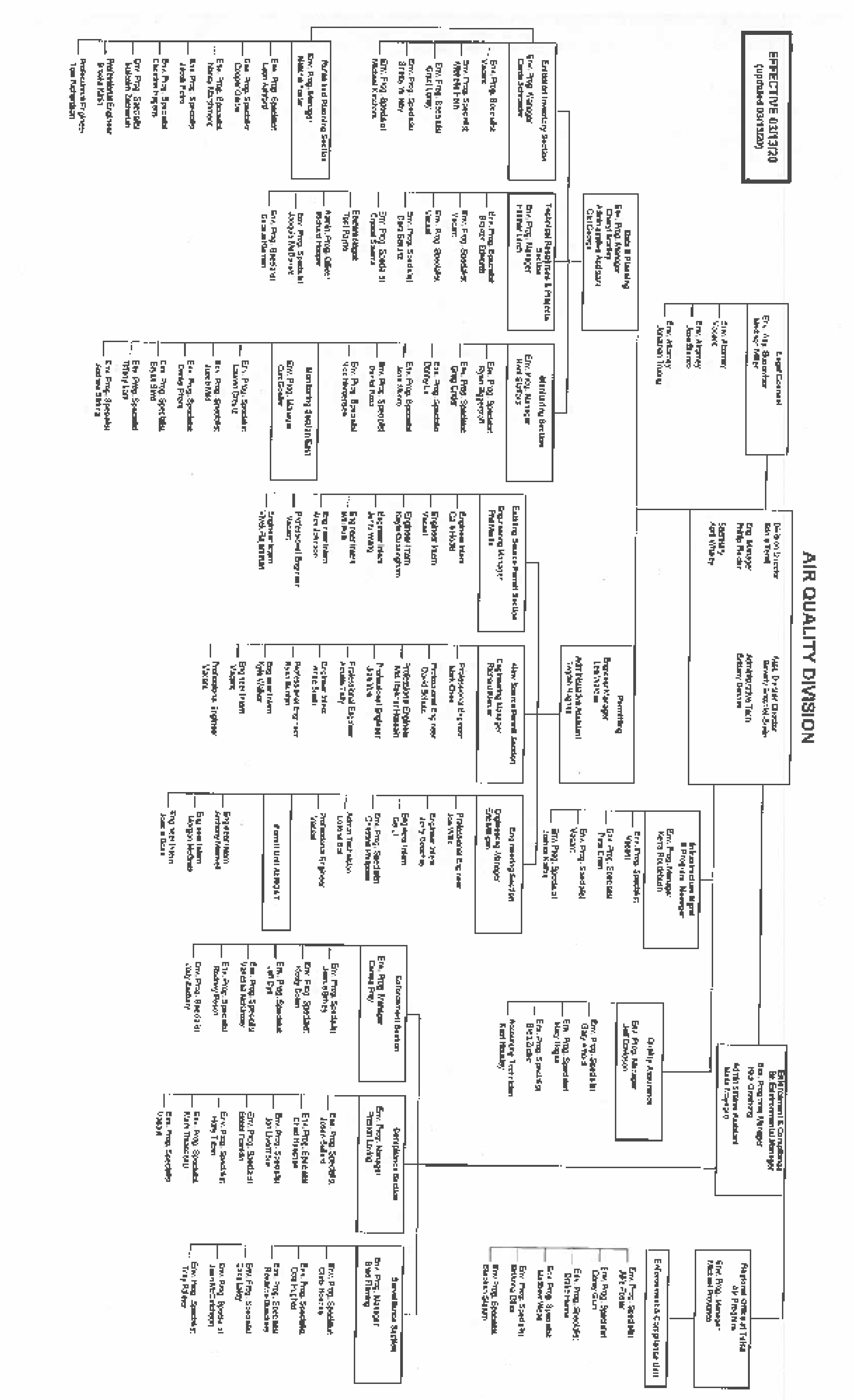
Collaborative Studies

ODEQ has partnered with the University of Oklahoma (OU) at the Kessler site for a focused study on ozone. ODEQ and OU will study ozone monitoring at multiple levels of the atmosphere using drone technology, piloted by OU, coupled with our NAAQS-comparable instruments.

Summary and Conclusions for the Assessment

- Overall, the network is efficient and effective in meeting both state and federal goals for air monitoring. Some changes are still expected to occur over the next five years to improve network quality, including:
  - Utilizing new small sensors for site placement to the benefit of the network.
  - Tulsa CBSA will surpass 1 million people, initiating the establishment of a PAMS and a Near-Road site. The following monitors will be added.
    - NOx
    - CO
    - Direct NO_2
    - PM 10
  - Addition of AQS Site # 40-087-1074 (Kessler)
  - Addition of AQS Site # 40-075-0177 (Great Plains State Park)
  - Relocation of AQS Site # 40-143-0174 (Goldsby)
  - Removal of redundant site and monitor, AQS Site # 40-143-0179 SO_2
    - H_2S will be relocated to AQS Site # 40-143-0175.
  - Removal of AQS Site # 40-101-0170 and AQS Site # 40-097-0188 with completion of DRR and subsequent approval by Region 6 EPA.
- The state is using up-to-date technology in all aspects of its network, including monitoring and data collection.
  - The primary change to the network in the last five years was the switch from Beta Attenuation PM monitors to Broadband Spectroscopy PM monitors. There is no current plan to update further technology in the network, but the state will continue its efforts to improve all portions of the network's technology.
- A robust network of PM 2.5 and O_3 sites near the state's three largest MSAs provide the infrastructure for the required AQI and will be continued.
- The state's Air Quality Health Advisory Program benefits its citizens and will be continued as long as resources allow. The additional O_3 and PM 2.5 samplers operated for this program provide a valuable health service and should be continued.
- Special purpose monitors along the Red River provide valuable information regarding O_3 transport across state lines and should be continued.
- The small sensors study is an asset to ODEQ and should be continued.
- The NATTS program will be a valuable asset to the state of Oklahoma and ODEQ looks forward to further coordination with the EPA on this objective.
- In light of current world events, ODEQ has realized the need for changes in the network to address extenuating circumstances and full site coverage. While adjustments are currently being made, we will continue to improve our capabilities, coordination, and communication to address possible scenarios.

Appendix A: Staffing Patterns



Appendix B: Site List with Parameters

AQS Site #	Address/ Location	Latitude	Longitude	Pollutants Measured	Sampling/Analysis Method	Station Type	Operating Schedule	Monitoring Objective	Spatial Scale	NAAQS Comparable	MSA/ CBSA[1]
40-109-0035	N.W. 5th and Shartel, OKC	35.472920	-97.527090	PM 2.5	Sequential FRM/ Micro-gravimetric filter weighing	SLAMS	(1 in 6)	Population Exposure	Neighborhood	Yes	OKC MSA
				PM 10	Sequential FRM/ Micro-gravimetric filter weighing	SLAMS	(1 in 6)	Population Exposure	Neighborhood	Yes	
				PM 10	Sequential FRM/ Micro-gravimetric filter weighing	SLAMS	(1 in 12) Collocated	Quality Assurance	Neighborhood	Yes	
				PM 10 - PM 2.5	Paired Gravimetric	SPM	(1 in 6)	Population Exposure	Neighborhood	No	
40-027-0049	S.E. 19th St., Moore Water Tower, Moore	35.320105	-97.484099	Ozone	U.V. Absorption	SLAMS	Continuous	Population Exposure	Urban	Yes	OKC MSA
				PM 2.5	Broadband Spectroscopy	SPM[3]	Continuous	Population Exposure	Urban	Yes	
				PM 10	Broadband Spectroscopy	SPM[3]	Continuous	Population Exposure	Urban	No	
40-109-0096	12880 A N.E. 10th, Choctaw	35.477801	-97.303044	Ozone	U.V. Absorption	SLAMS	Continuous	Population Exposure	Urban	Yes	OKC MSA
40-109-0097	3112 N. Grand Blvd, OKC	35.503070	-97.577981	NO_2	Chemiluminescence	SLAMS	Continuous	Highest Concentration/ Near-Road	Micro	Yes	OKC MSA
				PM 2.5	Broadband Spectroscopy	SLAMS	Continuous	Population Exposure	Micro	Yes	
				PM 10	Broadband Spectroscopy	SPM	Continuous	Population Exposure	Micro	No	
				CO	Gas Filter Correlation	SLAMS	Continuous	Population Exposure	Micro	Yes	
				Black Carbon	Optical Absorption	SLAMS	Continuous	Population Exposure	Micro	No	

AQS Site #	Address/ Location	Latitude	Longitude	Pollutants Measured	Sampling/Analysis Method	Station Type	Operating Schedule	Monitoring Objective	Spatial Scale	NAAQS Comparable	MSA/ CBSA[1]
40-017-0101	12575 NW 10th, Water Tower, Yukon	35.479215	-97.751503	Ozone	U.V. Absorption	SLAMS	Continuous	Population Exposure	Neighborhood	Yes	OKC MSA
40-037-0144	City Water Plant, Mannford	36.105481	-96.361196	Ozone	U.V. Absorption	SLAMS	Continuous	Population Exposure	Urban	Yes	Tulsa MSA
40-101-0170	108 North 55th St. East, Fort Gibson	35.775813	-95.287067	SO_2[4]	U.V. Fluorescence	SLAMS	Continuous	Source Oriented	Neighborhood	Yes	Muskogee CBSA
40-143-0174	502 E. 144th Pl., Tulsa South, Tulsa	35.953708	-96.004975	Ozone	U.V. Absorption	SLAMS	Continuous	Upwind Background	Urban	Yes	Tulsa MSA
				PM 2.5	Broadband Spectroscopy	SPM[3]	Continuous	Population Exposure	Urban	Yes	
				PM 10	Broadband Spectroscopy	SPM	Continuous	Population Exposure	Urban	No	
40-143-0175	1710 W. Charles Page Blvd. Tulsa	36.149877	-96.011664	SO_2[4]	U.V. Fluorescence	SLAMS	Continuous	Source Oriented	Neighborhood	Yes	Tulsa MSA
40-143-0178	18707 E. 21st St., Tulsa East, Tulsa	36.133802	-95.764537	Ozone	U.V. Absorption	SLAMS	Continuous	Population Exposure	Urban	Yes	Tulsa MSA
40-143-0179	124 N. Riverside Dr. West, Tulsa	36.154830	-96.015845	SO_2[4]	U.V. Fluorescence	SLAMS	Continuous	Source Oriented	Neighborhood	Yes	Tulsa MSA
				H_2S	U.V. Fluorescence	SPM[5]	Continuous	Source Oriented	Neighborhood	No	

AQS Site #	Address/ Location	Latitude	Longitude	Pollutants Measured	Sampling/Analysis Method	Station Type	Operating Schedule	Monitoring Objective	Spatial Scale	NAAQS Comparable	MSA/ CBSA[1]
40-097-0188	470 13th St., MAIP, Pryor	36.228993	-95.269196	SO_2[4]	U.V. Fluorescence	SLAMS	Continuous	Source Oriented	Neighborhood	Yes	Not in MSA/ CBSA
40-147-0217	112 N Caney St., Copan	36.908183	-95.882623	Ozone	U.V. Absorption	SPM	Continuous	Regional Transport	Regional	No[6]	Bartlesville CBSA
				PM 2.5	Broadband spectroscopy	SPM[3]	Continuous	Regional Transport	Regional	No[6]	
				PM 10	Broadband spectroscopy	SPM	Continuous	Regional Transport	Regional	No[6]	
40-113-0226	1521 S. Lombard, Skiatook	36.355860	-96.012430	Ozone	U.V. Absorption	SLAMS	Continuous	Population Exposure	Urban	Yes	Tulsa MSA
40-143-0235	2443 S. Jackson Ave., Tulsa	36.126945	-95.998941	SO_2[4]	U.V. Fluorescence	SLAMS	Continuous	Source Oriented	Middle	Yes	Tulsa MSA
				H_2S	U.V. Fluorescence	SPM	Continuous	Source Oriented	Middle	No	
40-019-0297	Memorial Dr., Healdton City Lake, Healdton	34.244189	-97.462931	Ozone	U.V. Absorption	SPM	Continuous	Regional Transport	Regional	No[6]	Ardmore CBSA
				PM 2.5	Broadband Spectroscopy	SPM[3]	Continuous	Regional Transport	Regional	Yes	
				PM 10	Broadband Spectroscopy	SPM	Continuous	Regional Transport	Regional	No	
40-069-0324	Murray State College, Tishomingo	34.214818	-96.676936	Ozone	U.V. Absorption	SPM	Continuous	Regional Transport	Regional	No[6]	Not in MSA/ CBSA

AQS Site #	Address/ Location	Latitude	Longitude	Pollutants Measured	Sampling/Analysis Method	Station Type	Operating Schedule	Monitoring Objective	Spatial Scale	NAAQS Comparable	MSA/ CBSA[1]
40-121-0415	104 Airport Rd., McAlester Municipal Airport, McAlester	34.885608	-95.784410	Ozone	U.V. Absorption	SLAMS	Continuous	Regional Transport	Regional	Yes	McAlester CBSA
				PM 2.5	Broadband Spectroscopy	SLAMS	Continuous Primary	Population Exposure	Regional	Yes	
				PM 10	Broadband Spectroscopy	SPM	Continuous	Population Exposure	Regional	No	
				PM 2.5	Sequential FRM/ Micro-gravimetric Filter Weighing	SLAMS	(1 in 6) Collocated	Quality Assurance	Regional	Yes	
40-121-0416	108 N Main St., Savanna	34.829396	-95.843642	Lead	Hi-Volume	SLAMS	(1 in 6)	Source Oriented	Neighborhood	Yes	McAlester CBSA
				Lead	Hi-Volume	SLAMS	(1 in 12) Collocated	Quality Assurance	Neighborhood	Yes	
40-047-0555	11826 N 30th St, Kremlin	36.512363	-97.845959	SO_2[4]	U.V. Fluorescence	SLAMS	Continuous	Source Oriented	Neighborhood	Yes	Enid MSA
40-071-0604	306 E Otoe, Ponca City	36.697186	-97.081350	SO_2[4]	U.V. Fluorescence	SLAMS	Continuous	Population Exposure/ Source Oriented	Neighborhood	Yes	Ponca City CBSA
				PM 2.5	Broadband Spectroscopy	SLAMS	Continuous	Population Exposure	Neighborhood	Yes	
				PM 10	Broadband Spectroscopy	SPM	Continuous	Population Exposure	Neighborhood	No	
40-031-0651	2211 NW 25th, Lawton	34.632980	-98.428790	Ozone	U.V. Absorption	SLAMS	Continuous	Population Exposure	Urban	Yes	Lawton MSA
				PM 2.5	Broadband Spectroscopy	SPM[3]	Continuous	Population Exposure	Urban	Yes	
				PM 10	Broadband Spectroscopy	SPM	Continuous	Population Exposure	Urban	No	

AQS Site #	Address/ Location	Latitude	Longitude	Pollutants Measured	Sampling/Analysis Method	Station Type	Operating Schedule	Monitoring Objective	Spatial Scale	NAAQS Comparable	MSA/ CBSA[1]
40-043-0860	Seiling Municipal Airport, Seiling	36.158414	-98.931973	Ozone	U.V. Absorption	SLAMS	Continuous	General Background	Regional	Yes	Not in MSA/ CBSA
				PM 2.5	Broadband Spectroscopy	SPM[3]	Continuous	General Background	Regional	Yes	
				PM 10	Broadband Spectroscopy	SPM	Continuous	General Background	Regional	No	
40-109-1037	2501 E. Memorial Rd., Oklahoma Christian University, OKC	35.614131	-97.475083	SO_2[4]	U.V. Fluorescence	SLAMS	Continuous	Population Exposure	Urban	Yes	OKC MSA
				Ozone	U.V. Absorption	SLAMS	Continuous	Highest Concentration	Urban	Yes	
				CO	Gas Filter Correlation	SLAMS	Continuous	General Background	Urban	Yes	
				NO_2	Chemiluminescence	SLAMS	Continuous	Max Precursor Emissions Impact/ Area-wide NO_2 and RA40 NO_2 for OKC CBSA	Urban	Yes	
				Chemical Speciation	Low Volume Gravimetric/Micro-gravimetric filter weighing	SLAMS	(1 in 6)	Population Exposure	Urban	No	
				PM 2.5	Sequential FRM/ Micro-gravimetric filter weighing	SLAMS	(1 in 3) Collocated	Population Exposure	Urban	Yes	
				PM 2.5	Broadband Spectroscopy	SLAMS	Continuous Primary	Population Exposure	Urban	Yes	
				PM 10	Broadband Spectroscopy	SLAMS	Continuous	Population Exposure	Urban	Yes	

AQS Site #	Address/ Location	Latitude	Longitude	Pollutants Measured	Sampling/Analysis Method	Station Type	Operating Schedule	Monitoring Objective	Spatial Scale	NAAQS Comparable	MSA/ CBSA[1]
40-143-1127	3520 1/2 N. Peoria, North Tulsa- Fire Station #24, Tulsa	36.204902	-95.976537	Ozone	U.V. Absorption	NCore/ SLAMS	Continuous	Maximum Precursor Emissions Impact	Urban	Yes	Tulsa MSA
				Trace Level NO_2	Chemiluminescence	NCore/ SLAMS	Continuous	Maximum Precursor Emissions Impact/ Vulnerable and Susceptible Population	Urban	Yes	
				Trace level NOy	Chemiluminescence	NCore/ SLAMS	Continuous	Maximum Precursor Emissions Impact	Urban	No	
				Trace level CO	Gas Filter Correlation	NCore/ SLAMS	Continuous	Population Exposure	Urban	Yes	
				Trace level SO_2[4]	U.V. Fluorescence	NCore/ SLAMS	Continuous	Population Exposure	Urban	Yes	
				PM 2.5	Sequential FRM/ Micro-gravimetric filter weighing	NCore/ SLAMS	(1 in 3) Primary	Population Exposure	Urban	Yes	
				PM 2.5	Sequential FRM/ Micro-gravimetric filter weighing	NCore/ SLAMS	(1 in 6) Collocated	Quality Assurance	Urban	Yes	
				PM 2.5	Broadband Spectroscopy	NCore/ SPM[3]	Continuous	Population Exposure	Urban	Yes	
				PM 10	Broadband Spectroscopy	NCore/ SPM[3]	Continuous	Population Exposure	Urban	Yes	
				PM 10	Sequential FRM/ Micro-gravimetric filter weighing	NCore/ SLAMS	(1 in 3)	Population Exposure	Urban	Yes	
				PM 10 - PM 2.5	Paired Gravimetric – “calculated”	NCore/ SPM	(1 in 3)	Population Exposure	Urban	No	
				Chemical Speciation	Low Volume Gravimetric/Micro-gravimetric filter weighing	NCore/ SLAMS	(1 in 3)	Population Exposure	Urban	No	